Restricted Circulation

This paper is not an official document; it is for information only and must not be quoted in any printed publication.

Agricultural Memorandum No. 936

M N Hough

Climatic Aspects of Glyphosate Application and Uptake

The success of a spray application against weeds can be measured by how effective the spray is in reducing the weed population; while at the same time leaving the crop unscathed. However, the action of chemical sprays on weeds and crop depends upon the previous environment and growth of the plants, the environment during spraying, and the conditions afterwards. Timeliness is not just a matter of how many spray hours are available, but also the environment before, during and after spraying.

Glyphosate ("Roundup") is a chemical which is used to control the troublesome weed couch grass (Agropyron repens). Coupland and Caseley (1981) have reported a wide variety of effects due to environment on the speed of uptake of glyphosate sprayed onto couch. Effects of light, temperature, humidity, frost, rain, dew, wind and soil moisture are mentioned. Temperature and humidity, during and for 6-12 hours after spraying appear most important for uptake with high temperatures and humidity favouring rapid uptake. Low temperatures, particularly in the soil, for 3-4 weeks after spraying help to slow down regeneration from the rhizomes.

In a similar way Taylor, Davies and Cobb (1981) have described how temperature, light and humidity had marked effects on the penetration of bentazone herbicide used to control the weed Chenopodium album.

Weather and Spraying

Weather affects the operation of glyphosate spraying in two ways. One is the time available for operating a spray machine and the second are the conditions for glyphosate uptake during this suitable time. In order to compare climatic differences critical values for the weather elements have to be chosen, which are thought to control the available spraying time, and the uptake of glyphosate.

The weather factors wind speed and rainfall are considered to be important in deciding whether to spray or not. Wind speed affects spray drift and distribution while rainfall above 0.5 mm is known to wash off glyphosate (and other chemicals) and to reduce its effectiveness; small amounts of rain, or dew, are beneficial (Caseley and Coupland (1980)). The following definitions are used:-

A spray day. This was the fifteen hour period 0700 to 21.00 with at least eight of the hourly mean wind speeds below 10 kt, and with the total rainfall between 0900 and 2100 less than 0.6 mm.

A spray night. This is the eight hour period between 2200 and 0500 with at least four hourly mean wind speeds below 10 kt, and with the rainfall total between 2100 and 0900 below 0.6 mm.

The time periods for the rainfall measurements do not coincide with the time period for a spray day or night. This is because the majority of synoptic weather stations report 12 hourly rainfall amounts twice per day at the fixed hours 0900 and 2100. It has to be accepted that some discrepancy will occur due to this, but for comparison of stations the effects will probably be small.

Spray Days and Nights for Glyphosate

In order to determine the variation in the opportunity of spraying, four synoptic meteorological stations were chosen in the main cereal growing area of England. These are, Brize Norton (Oxfordshire), Honington (Suffolk), Waddington (Lincolnshire) and Leeming (N. Yorkshire). For each of these places hourly mean wind speeds and rainfall totals 2100 to 0900 and 0900 to 2100 were extracted by computer from data banks held at the Meteorological Office. The numbers of spray days and nights were obtained for the months July to October, and for the years 1973 to 1980. The results are plotted in figure 1.

It is immediately apparent that more opportunities exist for spraying by night than by day. The reason for this is that the wind is usually lighter at night than during the day. Another feature which is common to all the stations is that there are more opportunities for spraying by night in the summer months of July and August. Day-time spraying is more constant, though August and October tend to be the best months and September the worst. It is interesting to see that differences due to geographical location are small and not significant for farming practice.

Conditions for Glyphosate Uptake During Spray Days and Nights

Many factors are known to affect the rapidity of uptake of glyphosate, but perhaps the most important are the temperature and air humidity conditions during spraying, and for the six hours or so after spraying. Warm, humid conditions favour rapid uptake, whereas cold, dry conditions inhibit uptake. Humidity exerts the greatest control and weather data for the four stations have been examined for these factors. At each station, the spray days and nights were selected and for each spray day and night the average air temperature and air relative humidity was found by averaging the fifteen hourly values of temperature or relative humidity (spray day), or the eight values of temperature and relative humidity (spray night).

Figure 2 shows the results for humidity alone. The proportion of spray days and nights with mean relative humidity exceeding 80%, is expressed as a percentage of the total number of spray days or nights respectively. We see that spray nights were nearly always humid throughout the period July to October. Many of the less humid nights occurred during the exceptional summer of 1976. Spray days were far less humid, especially in the summer, though 60 to 60% of spray days in October had mean relative humidity above 80%. Again there is no variation in the geographical pattern which would be significant for farming.

The uptake of glyphosate is quickest when conditions are warm as well as humid. The proportion of spray days and nights with mean temperatures above 11.9°C and relative humidity above 80% was found. Since daytime temperatures during July and August are normally above 12°C we would expect spray days during these months with relative humidity above 80% also to exceed 12°C. This is true, but since humid spray days are rare in July and August the number of humid warm spray days in these months is also very low. In October when the number of humid spray days increases we find that the proportion of spray days which are warm as well as humid increases to between 10 and 25%.

For spray nights we find that the proportion which are humid and warm lies between 51 and 65% of all spray nights, during July and August. This proportion declines to between 11 and 18% in October.

Climate and Glyphosate Spraying - Conclusions

The climatic data given here shows that:-

1. More opportunities for spraying occur during the night especially in July and August.

2. Humid conditions which encourage rapid uptake occur on a very large proportion of spray nights.

3. Humid days are most frequent in October.

4. Both warm and humid conditions occur most frequently during the night in July and August.

The four meteorological stations chosen are all inland sites, at least 50 miles from the sea, situated on relatively flat terrain. Some modification to these results could occur for coastal sites, or for sites in hollows or valleys which are prone to cold air drainage or still, clear nights. During July and August coastal sites could be 1 to 1.5°C cooler at the warmest part of the day and above 1°C warmer by night. This probably would cause spray nights to be warmer near the coast, especially if the wind were onshore. Spray days on the coast would have nearly the same mean temperature since on the coast, the cooler afternoon period is offset by a warmer early morning and late evening period. In October temperature differences are very small during the day, but warmer near the coast at night.

Relative humidity is higher near the coast. This is particularly so during the afternoon in July and August when coastal areas could have about 10% higher relative humidity. Differences become negligible in October. Night time relative humidity is high both inland and near the sea.

On the whole, conditions for uptake would be slightly better near the sea than inland. However, the opportunities for spraying would be decreased near the coast due to higher wind speeds.

Sites in hollows or in valleys, which are prone to cold air drainage, will in general have night temperatures 1 to 2°C lower than other places. However, the humidity at night will also be high, and such places are more prone to fog formation which may well enhance uptake.

References

Caseley, J.C. and Coupland D.	1980	Effect of simulated rain on retention, distribution, uptake, movement and activity of difenzoquat applied to Avena fatua. Ann. Appl. Biol. 96, 111-118.
Coupland, D. and Caseley, J.C.	1981	Environmental influences on the effects of glyphosate on Agropyron Repens. Proc. conf. Grass Weeds in Cereals.
Taylor, F.E., Davies, L.G., and Cobb, A.H.	1981	An analysis of the epicuticular wax of Chenopodium album leaves in relation to environmental change, leaf wettability and the penetration of the herbicide bentazone. Ann. Appl. Biol. 98, 471-478.

Meteorological Office
Harrogate

January 1982

Figure 1

The number of spray days and spray nights for each of the months July to October.

Figure 2

The proportion, expressed as a percentage, of spray days with mean relative humidity above 80%, and the proportion of spray nights with mean relative humidity above 80%.

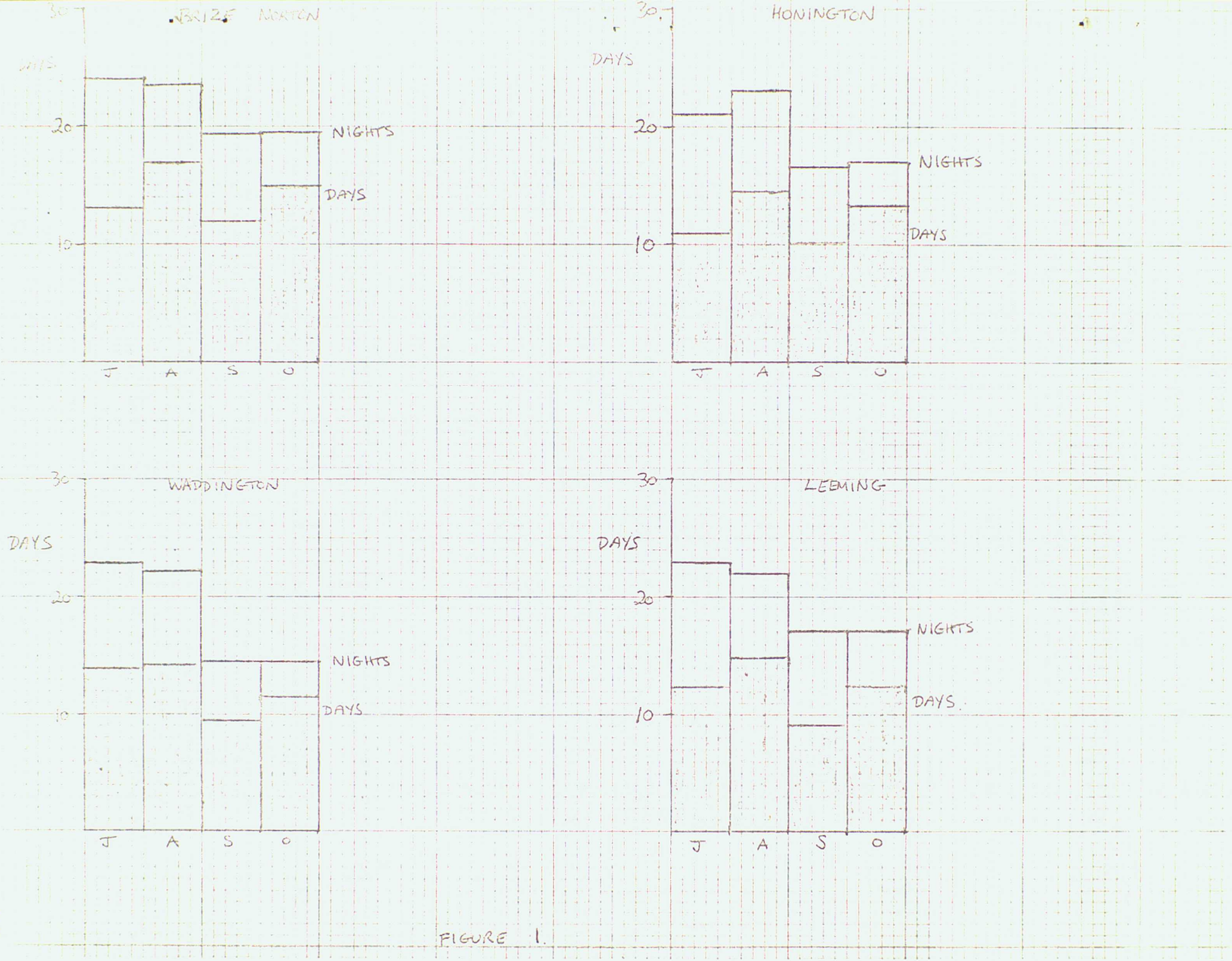
BRIZE NORTON
DAYS
30
20
10
NIGHTS
DAYS
J
A
S
O
HONINGTON
DAYS
30
20
10
NIGHTS
DAYS
J
A
S
O
WADDINGTON
DAYS
30
20
10
NIGHTS
DAYS
J
A
S
O
LEEMING
DAYS
30
20
10
NIGHTS
DAYS
J
A
S
O

FIGURE 1.

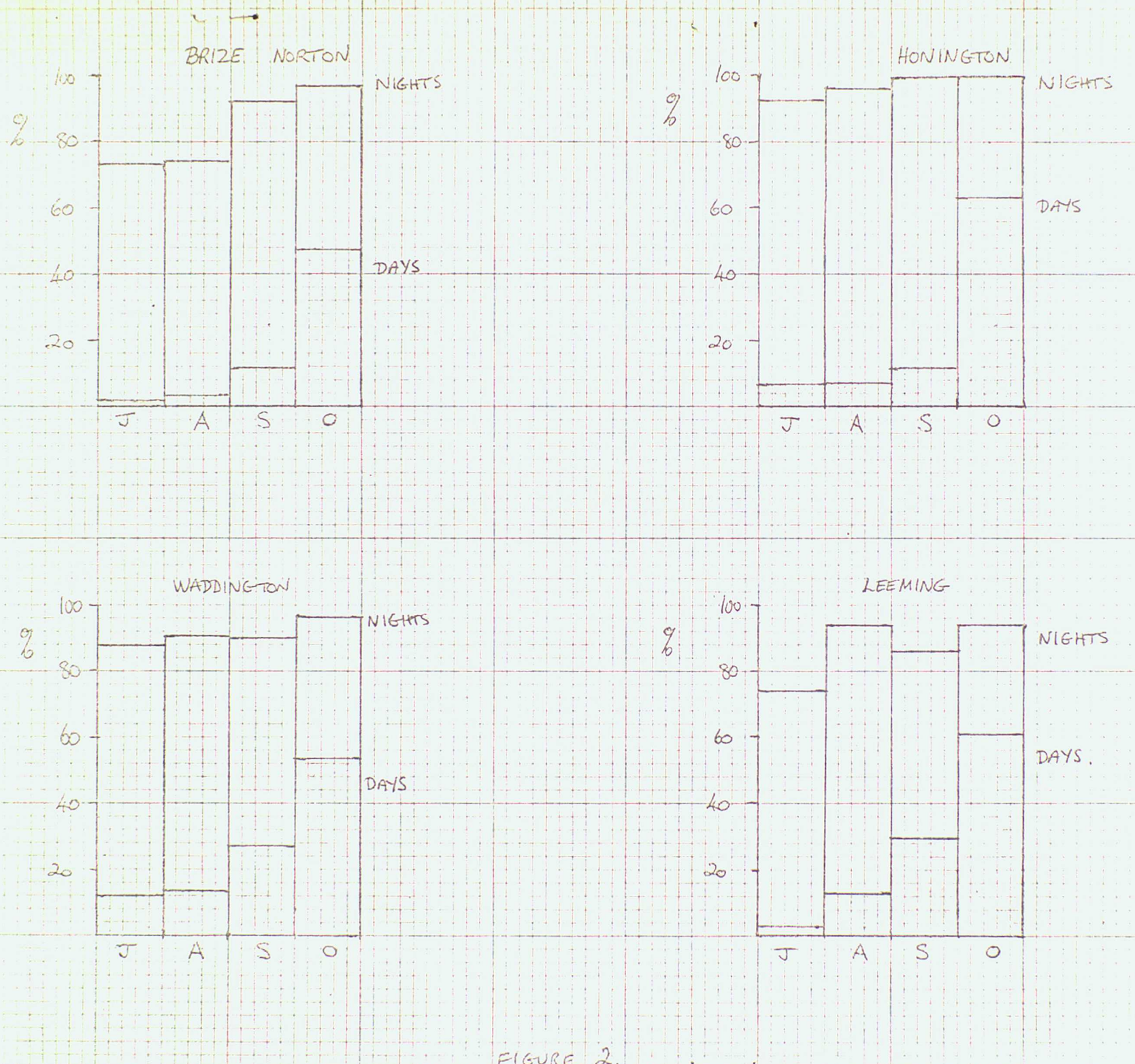
BRIZE NORTON
NIGHTS
DAYS
%
100
80
60
40
20
J
A
S
O
HONINGTON
NIGHTS
DAYS
%
100
80
60
40
20
J
A
S
O
WADDINGTON
NIGHTS
DAYS
%
100
80
60
40
20
J
A
S
O
LEEMING
NIGHTS
DAYS.
%
100
80
60
40
20
J
A
S
O

FIGURE 2.